



RECOMMENDATIONS / Technical

Hygiene recommendations for interventional radiology

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Abbreviations

AEB	Accident with exposure to blood
AFNOR	French standards agency
AFPPE	French association of electroradiological paramedical personnel
ARLIN	Regional office for the prevention of nosocomial infections
CLIN	Comité de lutte contre les infections nosocomiales (Committee for the prevention of nosocomial infections: since the <i>Hospital, Patients, Health & Regions</i> law in France, it is up to each EMC to set up the most suitable organisation, since a CLIN is no longer obligatory.)
CPE	Carbapenemase-producing enterobacteria
CSHPF	Conseil supérieur d'hygiène publique en France (High council for public hygiene in France)
CTINILS	Comité technique des infections nosocomiales et des infections liées aux soins (Technical committee for nosocomial and health care related infections)
CW	Contaminated waste from healthcare activities with an infectious risk
DGS	Direction générale de la sante (Department of Health)

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DHOS	Hospital and healthcare authority (now the DGOS, Direction générale de l'offre de soins [Healthcare provision authority])
EAU	European Association of Urology
EMC	Establishment's medical commission
EOH	Operational hygiene team
ESBL	enterobacteria: Extended spectrum beta-lactamase secreting enterobacteria
FB	Foreign body
FRI	Fédération de radiologie interventionnelle (Interventional Radiology Federation)
GPEM	Groupe permanent d'études des marchés (Permanent market studies group)
GRE	Glycopeptide-resistant enterococci
HAP	Hydro-alcoholic products
HAS	Haute Autorité de Santé (French National Authority for Health)
HCSP	Haut Conseil de la Santé publique (French National Council for Public Health)
HDR bacteria	Highly drug resistant bacteria
HE	Healthcare establishment
IR	Interventional radiology
MAP	Medically assisted procreation
MD	Medical devices
MDR bacteria	Multiple drug resistant bacteria
MRI	Magnetic resonance imaging
MSO	Medicine, Surgery, Obstetrics
NCW	Non-contaminated waste
PCNL	Percutaneous nephrolithotomy
PD	Peritoneal dialysis
SAT	Supra-aortic trunks
SFAR	Société française d'anesthésie et de réanimation (French Anaesthesia and Intensive Care Society)
SF2H	Société française d'hygiène hospitalière (French Hospital Hygiene Society)
SFR	Société française de radiologie (French Radiology Society)
TIPS	Transcutaneous intrahepatic portosystemic shunt

Compared with diagnostic imaging, which generally presents only a slight risk of infection, interventional radiology (IR), which is being performed more and more often, is confronted with a greater risk varying with the type of procedure and the condition of the patient. Many of these procedures resemble a surgical intervention, with not only an infectious risk for the patient, but also for the professional staff, due to the potential exposure to blood and biological fluids.

Its practical implementation must obey individual and collective rules of behaviour and organisation, compatible with the limitations of the guidance equipment and radio-protection rules.

The objective of these good practice recommendations is to propose measures for preventing and controlling the risk of infection, according to the different facets of IR, which are simple to apply and in-line with existing recommendations for surgery and vascular access. They have been developed by analysing the bibliography as exhaustively as possible and ensuring the absence of any contradiction with statutory requirements and current recommendations. They have not been rated in terms of force of the recommendation or level of evidence.

Rational

Epidemiological data

These data are very limited. In endovascular IR, a number of studies have evaluated the risk as 0.06% for percutaneous catheterisation, 0.64% for coronary angioplasty and 4.9% for all arterial and venous angioplasty [1–3]. Rates of 2.6% have been reported for hepatic abscess after chemoembolisation [4]. Bacteraemia has been found in 35% of patients, with a rate of clinical infection of 13% after making a transcutaneous intrahepatic portosystemic shunt (TIPS) [5].

The number of infections in percutaneous IR not using vascular catheterisation techniques also varies according to the procedure. As far as guided percutaneous liver punctures are concerned, the figures available vary from 0 to 0.3%, depending on whether therapeutic tumour destruction procedures are included, or not (radiofrequency) [6,7]. In ultrasound-guided endocavity IR, four observations of infection with *Pseudomonas aeruginosa* have been reported following ultrasound-guided transrectal biopsy [8]; the rate of infectious complications is between 3 and 10% [9]. For percutaneous gastrostomies, the risk of local infection is higher with a radiological approach than with an endoscopic approach (7.3% v. 1.7%) but with different antibiotic prophylactic practices, however [10].

Risk factors

The patient

The state of patients referred for IR is extremely variable and depends on their department of origin (e.g. intensive care), their age, subjacent pathologies, the evolution of the condition, the existence of factors favouring the infection, their immune status, the presence of invasive devices (catheters, probes), of skin lesions, the presence or not of infection, or whether they are carriers (known or not) of microorganisms with an epidemic potential, such as multiple drug resistant bacteria (such as MRSA, ESBL enterobacteria) and highly drug resistant bacteria (such as GRE and CPE). In addition, IR procedures, usually performed in a hospital environment, present a risk of exposure to blood and biological fluids for the professional staff.

The procedures performed

The procedures are extremely variable and carry very different risks. The French Radiology Society – Interventional Radiology Federation (SFR-FRI) has established a list of IR procedures, classifying them into three categories depending on the level of complexity, including the potential risks and in particular, the risk of infection [11]. Depending on local availability and the state of the patient, certain procedures may benefit from an improved level of environment. Table 1 only shows the most common procedures.

For each category, a certain number of precautions are required, the level of infectious risk determining the level of precautions to be taken.

In IR, controlling the risk of infection depends on strict compliance with standard hygiene precautions and on the existence of procedures defined, applied and evaluated for caring for and cleaning the different items of equipment

Table 1 Classification of interventional radiology procedures.

Nature of the procedure	Vascular and thoracic	Digestive	Urinary and genital	Bone
<i>Simple procedures</i> Type 1 Performed by any general radiologist	Phlebography	Diagnostic puncture Insertion of a nasogastric/jejunal, colon probe Intestinal disinvagination in a child	Diagnostic puncture \pm contrast agent Tubal opacification Ductography Needle aspiration cytology, microbiopsy, macrobiopsy, excisional biopsy guided en bloc Inserting markers on a guide (breast)	Arthrography, CT or MR arthrography Therapeutic intra-articular injection Myelography/CT scan Discography/CT scan Drug injection or nerve root destruction
<i>Intermediate procedures</i> Type 2 Performed in an IR structure forming part of an imaging unit, supported by an MSO HE	Arteriography Lymphography Angioplasty Endoprostheses Embolisations Peripheral vessel non-coated endoprostheses Chemoembolisation Thrombectomies Vena cava filters Foreign body extraction Central catheters with or without implantable chambers Thermoablation of lung cancers	Gastrostomy, jejunostomy Dilatation \pm endoprosthesis FB extraction All other procedures on the biliary and pancreatic ducts Thermoablation of liver cancers	Urinary tract dilatation Endoprosthesis JJ ablation Removal of FB Embolisation of the ureter, endo-ureteral balloons Nephrostomy Drainage collection \pm sclerosis PCNL Catheter for PD Tubal repermeabilisation/occlusion Embolisation of post-partum haemorrhage Radiofrequency, cryoablation of breast tumours Thermoablation of kidney cancers	Cementoplasty Vertebroplasty Thermoablation of bone tumours
<i>Complex procedures</i> Type 3 Specialised structure governed by the decree relating to interventional vascular neuroradiology [12]	SAT and carotid endoprostheses Coated aortic endoprostheses Cranial thrombectomies Endovascular treatment of aortic dissection Percutaneous porto-caval shunt			Kyphoplasty Nucleotomy Intradiscal injection, radiofrequency Radio-guided insertion of screws: spine, sacrum

used, in particular those used for guidance, and for maintaining the environment [13,14].

Recommendations

General hygiene rules

Awareness, information and training concerning the risks of infection

All medical and paramedical personnel must be informed of all the risks and the means to be used to control them. Training must be related to basic knowledge of hospital hygiene, microbiology and the epidemiological chain. More specifically, the training should allow the risks inherent in different situations encountered to be identified, as well as their level of danger and the methods for controlling the risk. Written procedures must thus be produced by consensus between the imaging professionals and the operational hygiene team (EOH) and validated by the establishment they must then be presented and made available to the personnel concerned, and their application must be evaluated, also with the help of operational hygiene teams (EOH) [15,16]. Depending on the size of the structure, it is desirable to appoint a medical and paramedical hygiene contact person. This contact will be responsible for passing on information, applying it and evaluating it [13,14,17,18].

R1. IR hygiene must be included in the training objectives of the various training courses offered to medical and paramedical personnel performing IR, both initial and in-service training.

R2. All measures relating to IR hygiene must be formulated according to the protocols validated by the structures responsible for the prevention of nosocomial infections. The personnel must know and apply these protocols and their use must also be evaluated.

Presentation and working clothes

Generally speaking, there should be no jewellery on the hands or wrists; hair should be short or held back.

For level 2 and 3 procedures that have to be performed in a protected structure with a controlled environment like an operating theatre, clothing reserved for the purpose in an identifiable colour, preferably a tunic and trousers, should be worn inside the structure by all the personnel. This clothing should be put on at the entrance of the structure, which must have an obligatory airlock and a suitable changing room. This clothing must not be worn outside the structure and must be changed at least each day and when soiled. It will be worn with working shoes reserved for the purpose and a disposable hair cap. A surgical mask must without fail be worn in the intervention room. A sterile surgical gown will also be worn by the operator and his or her assistant(s),

together with eye protection (visor protecting the leaded radioprotection glasses) [19].

R3. For level 2 and 3 procedures, complete surgical clothing, including a surgical mask with an eye protection visor, is obligatory.

For category 1 procedures, it is recommended that working clothes be worn, preferably the tunic and trousers. The use of a protective gown is desirable, as well as any appropriate individual protection equipment, as a standard hygiene precaution, if exposure to body fluids could occur.

Hand hygiene [20]

This is a fundamental point which is based on the strict absence of jewellery on the hands and wrists (including wedding rings) and on the application of a rigorous protocol:

- simple washing: this must be performed by all the personnel using water for standard care and a mild liquid soap, followed by drying by dabbing with disposable paper towels. It must be performed when the member of staff comes on duty, at the entrance to the structure, then on performing any of the actions of normal life. A hydro-alcoholic handrub may be used as a substitute on hands which are not soiled;
- hygienic hand friction: the standard technique is hydro-alcoholic friction, performed on dry and totally unsoiled hands, where there is no context of carrying a sporulating organism (*Clostridia difficile*) or parasite (scabies). It must be performed before and after any contact with a patient, each time gloves are put on or changed and between the various stages of a technical procedure. It is a very effective process, when the correct technique is followed (in seven successive stages) including waiting for the product to dry spontaneously;
- surgical disinfection of the hands: obligatory for invasive processes equivalent to surgical procedures, the standard technique is also hydro-alcoholic friction, with however, certain special features:
 - it is preceded by simple hand-washing, with only the nails being brushed,
 - two successive sessions of hydro-alcoholic hand friction are undertaken, the first including the forearms up to the elbow, the second including the wrists,
 - surgical gloves are then put on. Double gloving should be preferred [15] with the external pair of gloves being systematically changed every hour in long procedures [21],
 - when a ring dosimeter is used, the ring is cleaned in advance by immersion in a detergent-disinfectant bath, rinsed, dried, then despite this, disinfected (both outer and inner surfaces with a hydro-alcoholic product) and put onto the finger. Surgical disinfection of the hands follows, with the ring in place [22].

Wearing gloves is part of hand hygiene, but it is only essential in the following situations:

- in invasive procedures, the gloves then being sterile [21,23,24];

- in vascular compression [3], where the use of sterile or non-sterile gloves should be systematic;
- in other predictable exposure to blood or biological fluids and/or in procedures with a low risk of infection, such as inserting a peripheral venous catheter; in the case of contact with a patient known to be a carrier of certain bacteria with a high level of resistance to antibiotics, such as GRE or CPE [25,26] or scabies; if there is direct contact with a patient's skin lesions or mucosa; when handling used linen, waste material, or removing faeces, urine or any other product of biological origin; if there are skin lesions on the hands of the professional personnel. In these cases, non-sterile disposable gloves will be used [27].

Gloves need not be worn for contact with healthy skin, in the absence of any puncture, but hydro-alcoholic friction should be used before and after contact [18,20].

R4. Hand hygiene protocols must be accessible, personnel must be trained and hand hygiene points must be provided and regularly restocked. The protocols must specify the indications for hand hygiene, the techniques to be used and the indications for wearing gloves. Practice must be regularly evaluated.

The microbiological quality of the water

For all interventional procedures, water for standard care is a suitable quality, particularly for hand hygiene before hydro-alcoholic friction. Water for standard care could be recommended when the microbiological quality parameters of the water persistently fail to comply for a team which has not adopted surgical hydro-alcoholic friction of the hands [20].

Cleaning and care of the premises

There must be strictly traceable application of maintenance, cleaning and disinfection protocols for the floors and surfaces according to the previously defined infectious risk for each area [28]. For level 1 procedures, the disposable protection must be changed and the examination table systematically wiped with a detergent–disinfectant product between two patients.

For intervention rooms, protocols must be defined for cleaning between each procedure, at the end of the operating programme and thoroughly each week. If there is an emergency occurring at night, or at the end of the week, measures must be taken once the procedure has finished so that the room is made fit for use again.

R5. For level 2 and 3 procedures, the cleaning and disinfection rules for the premises must be the subject of biological decontamination protocols similar to those for an operating theatre. These protocols are established in collaboration with the operational hygiene team, validated by the establishment,

distributed and evaluated. Their application must meet traceability requirements.

Management of reusable medical devices

To achieve optimal microbiological quality, the use of disposable material should be preferred [29]; its reuse is forbidden.

The final microbiological quality required of medical devices depends on their use and the anatomical location into which the device is introduced. Table 2, adapted from Spaulding's classification, summarises the possible proposals [30].

In using ultrasound guidance for interventional purposes, the rules of good practice issued by the Academy of Medicine and HCSP (the French national council for public health) must be applied [31,32]. These rules particularly concern the precautions to be taken when using protective sheaths for probes, defined in the HCSP report [33].

Finally, the microbiological quality of ultrasound gel was specified in 1996 in another circular letter [34]. A proposed use of the different types is set out below in Table 3.

R6. The microbiological quality level of medical devices is adapted to the use made of them. The sterilisation procedures and MDs concerned are defined with the sterilisation department taking into account the manufacturer's recommendations. The disinfection procedures are defined with the operational hygiene team (EOH), taking into account the manufacturer's recommendations. They are validated by the establishment, distributed and evaluated; their application must meet traceability requirements.

Preparation of the patient

Preparation of the patient's skin

For level 2 and 3 procedures, the rules for preparation are analogous to preoperative preparation for surgery, the importance of which for preventing postoperative infection has been widely demonstrated [35–37].

The patient should shower, at home or on the ward before the procedure. On arrival of the patient, his or her physical cleanliness should be visually checked:

- shaving is not permitted [38], if there is hyperpilosity of the area for the percutaneous approach, it could, if necessary, be replaced by depilation using clippers with a disposable head. If depilation is carried out, it will preferably be followed by a shower;
- in the intervention room, the skin is prepared in four stages (cleaning, rinsing, drying, antisepsis with an antiseptic, preferably alcoholic), immediately before the incision or puncture;
- setting up the fields.

Table 2 Classification of the different microbiological qualities required depending on the anatomical site.

Anatomical site of use	Criticality level	Level of risk of infection	Treatment required	Microbiological efficacy targeted
Vascular system, cavities, sterile tissue	Critical	High	Sterile single use or failing this sterilisation (autoclave, or low temperature using gas plasma) or failing this high level disinfection by immersion with rinsing in sterile water	Bactericidal, mycobactericidal and sporicidal Fungicidal Virucidal
Mucosa, damaged skin	Semi-critical	Moderate	Intermediate level disinfection by immersion with rinsing in water for standard care	Bactericidal and mycobactericidal Fungicidal Virucidal
Healthy skin or with no contact	Non-critical	Low	Low level disinfection By immersion and rinsing in water for standard care By contact by wiping with a detergent-disinfectant product	Bactericidal

Table 3 Microbiological quality of the various types of ultrasound gel.

250 ml bottle to be changed each day	Single dose	Sterile single dose
Transparietal ultrasound, run-of-the-mill transcutaneous ultrasound on healthy skin	Transparietal ultrasound on healthy skin in patients requiring contact precautions (MDR bacteria etc.) both in radiology and at the patient's bedside Endocavity ultrasound without biopsies	Transparietal ultrasound On damaged skin On recent operation wound < 8 days Patient in a protected sector Neonatal patients In the operating theatre In MAP Ultrasound-guided punctures

For type 1 procedures, the skin is prepared with the same four stages, but the preliminary shower is not required. Setting up sterile fields follows the same protocol. Skin preparation without the cleaning stage but with two successive applications of an alcoholic antiseptic may only be used for the insertion of peripheral venous catheters which have a very short period of insertion [13] (in practice two hours appears to be a reasonable period).

R7. Preoperative preparation of the patient is the subject of a four stage protocol, validated by

the establishment, distributed and evaluated. Its application is recorded in the patient's file.

Antibiotic prophylaxis

While there are no controlled trials which establish formal evidence of the benefit of antibiotic prophylaxis in IR, this should be envisaged in certain circumstances [39–41]. Its use must be justified due to the potential risks of inappropriate use (selection of resistant microorganisms,

hypersensitivity). Decided by multidisciplinary agreement [42], it must be the subject of a departmental protocol, based on the consensus conference of the French Society of Anesthesia and Resuscitation in cooperation with the learned societies concerned and in particular with the FRI, updated the recommendations on perioperative antibiotic prophylaxis in surgery, radiology and interventional medicine in 2010 [43]. Antibiotic prophylaxis is thus recommended for endoscopic gastrostomies, sclerosis of oesophageal varices, endoprostheses and stents (except intracoronary stents). It should also be envisaged in certain at-risk subjects. Evaluation of professional practice is strongly recommended; it can be based on the reference document *Évaluation des pratiques d'antibioprophylaxie* (Evaluation of antibiotic prophylaxis practices) [44].

R8. If antibiotic prophylaxis is recommended for certain IR procedures, it will follow the SFAR indications and will be the subject of regularly updated departmental protocols available in the intervention rooms. It is prescribed at the time of taking the decision to perform an IR procedure; its administration is recorded in the patient's file.

The structure of interventional radiology

Level 1 procedures

Level 1 procedures (guided, diagnostic and/or therapeutic punctures) are generally performed in a radiodiagnostic room (conventional radiology, ultrasonography, CT-scan, even MRI in the near future) generally not specifically reserved for IR. Performing these procedures involves substantial functioning modifications to such a room, making it highly desirable to group procedures together within a given period of time. In addition to the usual daily cleaning and maintenance, waste must be eliminated at the end of each procedure, and surfaces in contact with or close to the patient must be disinfected by wet wiping, before the next procedure. Inadvertent entry to this room must be prevented; it must be equipped with a point for washing and disinfecting hands and should contain as few consumables as possible, preferably in mobile cupboards.

R9. Level 1 procedures involve a series of organisational measures aimed at controlling the risk of infection.

Level 2 and 3 procedures

For category 2 and 3 procedures, the use of a structure analogous to that of an operating theatre should be the rule, according to the regulations [45]; if this is not the case, developing the structure to comply with this must be a high priority objective within a reasonable time. Whether a new area is created or existing premises refurbished, while forming part of the imaging unit this area must be independent, separate from the rest of the department with premises with

a controlled environment, compatible with an ISO 7 level of performance in the actual intervention rooms [46], in accordance with controlled access rules. Inside this area, the different types of rooms must be organised into zones depending on the different levels of risk of infection.

R10. Level 2 and 3 procedures must obey operating theatre rules, as regards both the arrangement and the functioning of the structure.

This area comprises two parts which are separate but close to one another [47].

The reception and postintervention area

This includes a waiting room for outpatients which may also be the department's waiting room. For patients undergoing a procedure as outpatients, it is desirable to have rooms fitted out for day hospitalisation. It is recommended that the bed or stretcher should be changed for inpatients. This area includes a postintervention observation room, which must be close to the intervention room but may also be the same room as for the surgical operating theatres. It must comply with the 1994 decree governing anaesthetic safety [48]. The rules of hygiene for this part of the area are the same as those for any postintervention area.

The actual interventional area

This is centred on the intervention room, to which are attached annexes, some being essential, others optional. During renovation, refurbishment, or design of new interventional areas, the area must be designed with circuits which apply the 'moving forward' principle and the concept of 'progressive asepsis'. The arrangement and construction of premises, the nature of surface coverings, the quality of surfaces and the furnishing must be decided in collaboration with hygiene specialists, in order, particularly, to facilitate cleaning and disinfection operations.

In existing structures, where architectural constraints have not taken these preoccupations into account, circuits and procedures should be defined based on multidisciplinary considerations specific to each structure:

the intervention room: this must combine the requirements necessary for image quality and radioprotection and operating theatre hygiene rules. The special features of IR nevertheless involve using a number of pieces of equipment not found in a surgical operating theatre. These pieces of apparatus (injector, ultrasonograph, lead screens etc.) should preferably be moveable, stored outside of the room when they are not in use, except for those fixed to the intervention table or on the monitors. The radiological apparatus must be optimised to facilitate cleaning; the complexity of the apparatus sometimes involves special protocols: to facilitate maintenance, sheaths containing the wiring, tactile screens and keypads, and even immersible keyboards may be indicated here. On acquiring new apparatus it should be particularly ensured that prerequisites concerning cleaning and disinfection should be included in the specifications. Active ingredients (and not the products, in order to avoid being restricted to one product) compatible with the material must without fail be specified by the constructors before any purchase. False ceilings and false floors should be avoided

whenever possible, as they are sources of dust which are difficult to access for cleaning. The room must be away from circulation pathways, with access via automatic sliding doors.

The annexes include:

- a changing room for the personnel. This is obligatory and must allow them to change their clothes and permit basic hand-washing;
- the interventional preparation area. A surgical hand disinfection point is located immediately before the entrance to the room, inside the access airlock, or not;
- the storage room or rooms for the different types of material used;
- the image processing room. This is essential and must be equipped in such a way as to prevent personnel going in or out in a way that is incompatible with the hygiene rules;
- the various logistics rooms. The predisinfection room, dirty linen and waste storage room, clean linen room, cleaning room and sluice room may possibly be shared with the rest of the imaging sector, depending on their arrangement.

The circuits [47,48]

The circuits are organised according to the architectural possibilities and must be observed by all the personnel:

- patient circuit: the various stages (reception, preparation, waiting, procedure, post-procedure, discharge) are adapted depending on the patient (whether outpatient or inpatient) and the procedure (whether programmed or urgent). The patient enters through a specific, automatic and lockable door. It is currently recommended that patients who are or presumed to be carriers of an HDR bacteria (GRE, CPE etc.) should be dealt with so as to avoid their being in the waiting room or reception area with other patients for any length of time; scheduling their intervention at the end of the day is not useful, once cleaning procedures have been defined and controlled;
- personnel circuit: this passes through an obligatory undressing airlock or changing room where clothes can be changed and hands washed. A staff rest room inside the structure is optional but desirable to avoid excessive circulation. Eating solid food inside the intervention area must be prohibited;
- materials circuit: there should be a specific access for this through a door which is inaccessible from the outside, and enable the delivery of the various types of material necessary. Delivery boxes must be unpacked outside the intervention area, where there should be access into the storage area. Waste material is sorted at source depending on its nature, with contaminated waste (CW) from healthcare activities with an infectious risk, including sharps (blades, needles, trocars), disposed of into special tamper-free, burnable collectors, and non-contaminated waste (NCW). Waste must be stored and disposed of according to the circuit defined by the establishment [49]. 100% cotton cloth should be abandoned for polyester/cotton (cleaned by the structure) or better still, disposable linen could be used which would then enter the same circuit as the CW. Reusable medical devices are immersed close to their point of use in a detergent-disinfectant bath and then follow the circuit defined in the establishment.

R11. The IR sector will be organised to take account of hygiene requirements, defining the circuits that patients, personnel, material and products, linen and waste material must follow.

The environment

For level 2 and 3 activities, the quality of the air must be at ISO 7 level, with an air exchange rate of 25 to 30 volumes/h, positive pressure of at least 15 Pascals and terminal filtration by high efficacy particulate air filters [46]. Any renovation, restructuring or construction projects should provide the opportunity for interventional radiology centres to include these recommendations in the development of their premises

Organisational aspects

Programming patients

For level 1 procedures, we must again insist on the need to group guided procedures in the same room, so that it is adequately fitted out and prepared for performing them. For level 2 and 3 procedures, performed in an intervention room with air treatment, the order of treatment of patients according to their infectious status has no influence on biological contamination of the air, if the hygiene recommendations are observed [50]. It is no longer recommended therefore, to schedule infected patients or those presumed to be infected (irrespective of the nature of the infection, e.g. a purulent collection or a patient colonised by an MDR or HDR bacteria) at the end of a session or during specific periods of time.

Protection of the personnel

The standard precautions should be strictly applied, by all, for all procedures, and for all patients. Individual protection equipment and collectors for piercing and cutting objects must be available. The action to be taken in the event of an accident with exposure to blood or biological fluids must be the subject of a management procedure which is on display and known to all [27,51].

R12. All medical and paramedical personnel must be trained in and informed of the risks and measures to be taken in the event of exposure to blood and biological fluids.

References

- [1] Meyerson SL, Feldman T, Desai TR, Leef J, Schwartz LB, McKinsey JF. Angiographic access site complications in the era of arterial closure devices. *Vasc Endovasc Surg* 2002;36: 137–44.
- [2] Joffre F, Besset J, Rousseau H, Ramon H, Chapuis G, Benne M. Le risque infectieux en radiologie vasculaire et interventionnelle. *Lett Infectiol* 1993;9:305–8.

- [3] Baffroy-Fayard N. pour le groupe de travail du CLIN Paris-Nord. Hygiène en radiologie interventionnelle : présentation d'un guide de bonnes pratiques. *J Radiol* 2002;83:351–9.
- [4] de Baère T, Roche A, Amenabar JM, Lagrange C, Ducreux M, Rougier P, et al. Liver abscess formation after local treatment of liver tumors. *Hepatology* 1996;23:1436–40.
- [5] Halpenny DF, Torreggiani WC. The infectious complications of interventional radiology based procedures in gastroenterology and hepatology. *J Gastroenterol Liver Dis* 2011;20:71–5.
- [6] Cervini P, Hesley GK, Thompson RL, Sampathkumar P, Knudsen JM. Incidence of infectious complications after an ultrasound-guided intervention. *AJR* 2010;195:846–50.
- [7] Giorgio A, Tarantino L, de Stefano G, Coppola C, Ferraioli G. Complications after percutaneous saline-enhanced radiofrequency ablation of liver tumors: 3-years experience with 336 patients at a single center. *AJR* 2005;184:207–11.
- [8] Gillespie J, Arnold KE, Kainer MA, Noble-Wang J, Jensen B, Arduino M, et al. *Pseudomonas aeruginosa* infections associated with transrectal ultrasound-guided prostate biopsies. *MMWR* 2006;55:776–7.
- [9] Grabe M, Botto H, Cek M, Tenke P, Wagenlehner FM, Naber KG, et al. Preoperative assessment of the patient and risk factors for infectious complications and tentative classification of surgical field contamination of urological procedures. *World J Urol* 2012;30(1):39–50.
- [10] Silas AM, Pearce LF, Lestina LS, Grove MR, Tosteson A, Manganiello WD, et al. Percutaneous radiologic gastrostomy versus percutaneous endoscopic gastrostomy: a comparison of indications, complications and outcomes in 370 patients. *Eur J Radiol* 2005;56:84–90.
- [11] Joffre F, pour le groupe Société française de radiologie – Fédération de radiologie interventionnelle. Présentation de la Radiologie interventionnelle en France en 2010. *J Radiol* 2011;92:623–31.
- [12] Décret n° 2006-73 du 24 janvier 2006 relatif à la neurochirurgie et activités interventionnelles par voie endovasculaire en neuroradiologie.
- [13] Ministère de la Santé, HCSP, SFHH. Surveiller et prévenir les infections associés aux soins. Septembre 2010. http://www.sf2f.net/publications-SF2H/SF2H_surveiller-et-prevenir-les-ias-2012.pdf
- [14] Siegel JD, Rhinehart E, Jackson M, Chiarello L and the healthcare Infection Control Practices Advisory Committee Guidelines for isolation precautions: preventing transmission of infectious agents in healthcare settings 2007 <http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf>.
- [15] Centre de coordination de la lutte contre les infections nosocomiales de l'inter-région Paris-Nord. Hygiène en Radiologie invasive. Rapport d'audit.04/1997.
- [16] Thomila M, Parneix P, Rogues AM. L'élaboration de protocoles de soins en imagerie médicale: une étape vers la prévention de l'infection. *Hygiènes* 1995;10:47–51.
- [17] Circulaire n° DHOS/E2/2007/109 du 23/03/2007, relative à la stratégie nationale d'audit des pratiques en hygiène hospitalière pour 2007 Méthodologie d'audit sur la préparation cutanée préopératoire élaborée par le groupe de recherche et d'évaluation des pratiques en hygiène hospitalière.
- [18] SF2H. Recommandations nationales: prévention de la transmission croisée: précautions contact. Avril 2009. http://www.sf2h.net/publications-SF2H/SF2H_preventiontransmissioncroisee-2009.pdf
- [19] Leaman DM, Zelis RF. What is the appropriate "dress code" for the cardiac catheterization laboratory? *Catheter Cardiovasc Diagn* 1983;9:33–8.
- [20] SF2H Recommandations pour l'hygiène des mains. Juin 2009 [http://www.sf2h.net/publications-SF2H/SF2H_recomm-](http://www.sf2h.net/publications-SF2H/SF2H_recommandations-hygiene-des-mains-2009.pdf)
[andations-hygiene-des-mains-2009.pdf](http://www.sf2h.net/publications-SF2H/SF2H_recomm-).
- [21] Johanet H, Chosidow D, Marmuse JP, Benhamou G. Le gant de chirurgie: quelles sont les fréquences, mécanismes et risque de leur perforation et de leur porosité? *Hygiènes* 1997;1:39–42.
- [22] Valdeyron ML, paix V, Girard R, Perraud M. Validation d'une méthode de friction des mains portant une bague de dosimétrie. *Hygiènes* 2009;5:393–6.
- [23] Joffre F, Otal P, Janne d'Othée B. Plea for a "surgical conscience" in the interventional radiology suite. *Cardiovasc Intervent Radiol* 1998;21:445–7.
- [24] Gerberding JL, Littell C, Tarkington A, Brown A, Schecter WP. Risk of exposure of surgical personnel to patients' blood during surgery at San Francisco General Hospital. *New Engl J Med* 1990;322:1788–93.
- [25] Note DGS/DHOS du 6 décembre 2006 relative à la prévention de l'émergence d'épidémies d'ERV dans les établissements de santé.
- [26] Circulaire DGS/RI/DGOS/PF/2010/413 du 6 décembre 2010 relative à la mise en œuvre de mesures de contrôle des cas importés d'entérobactéries productrices de carbapénémases.
- [27] Circulaire DGS/DH n° 98-249 du 20 avril 1998 relative à la prévention de la transmission d'agents infectieux véhiculés par le sang ou les liquides biologiques lors des soins dans les établissements de santé.
- [28] Guide du bionettoyage GPEM/SL: Recommandations n°E-1-190 1994.
- [29] Circulaire DGS/SQ3, DGS/PH2- — DH/EM1 n° 51 du 29/12/1994 relative à l'utilisation des dispositifs médicaux stériles à usage unique dans les établissements de santé publics et privés.
- [30] CSHPF et CTIN: désinfection des dispositifs médicaux: guide de bonnes pratiques. Ministère de l'Emploi et de la Solidarité, 1998.
- [31] Cabanis A, Chouard CH: Rapport de l'Académie nationale de Médecine. 14/01/2010: Les bonnes pratiques de désinfection des sondes d'échographie endo-vaginales et endo-rectales.
- [32] Avis HCSP relatif à la désinfection des sondes d'échographie endocavitaire. 17 octobre 2008. http://www.hcsp.fr/docspdf/avisrapports/hcspa20081017_desoneche.pdf
- [33] Rapport HCSP-CTINILS, 14/12/2007: Gaines de protection à usage unique pour dispositifs médicaux réutilisables: Recommandations d'utilisation. http://www.hcsp.fr/docspdf/avisrapports/hcspr20071214_gainesProtec.pdf
- [34] Circulaire EM1/DH n° 960479 du 6 février 1996, portant sur les recommandations relatives à l'usage du gel d'échographie.
- [35] Mangram AJ, Horan TC, Pearson ML, and the HICPAC. Guidelines for prevention of surgical site infection. *Am J Infect Control* 1999;27:97–134.
- [36] Consensus conference "Gestion préopératoire du risque infectieux". March 2004.(being revised).
- [37] Surgical site infection: prevention and treatment. Clinical guidelines. National institute for Health and clinical excellence. October 2008; 142 pp. <http://www.nice.org.uk/CG74>
- [38] Seropian R, Reynolds BM. Wound infections after preoperative depilatory versus razor preparation. *Am J Surg* 1971;121:251–4.
- [39] Vidal V, Bartoli JM, Kobeiter H. Prescription médicamenteuse en radiologie interventionnelle pour les risques infectieux. In: Beregi JP, editor. Radiologie interventionnelle des artères rénales ». Paris: Springer-Verlag; 2008, 207–18.
- [40] Spies JB, Rosen RJ, Lebowitz AS. Antibiotic prophylaxis in vascular and interventional radiology: a rational approach. *Radiology* 1988;166:381–7.
- [41] Ryan JM, Ryan BM, Smith TP. Antibiotic prophylaxis in interventional radiology. *J Vasc Interv Radiol* 2004;15:547–56.
- [42] Venkatesan AM, Society of Interventional Radiology Standards of Practice Committee. Practice guidelines for adult antibiotic prophylaxis during vascular and interventional radiology procedures. Written by the Standards of Practice Committee for the Society of Interventional Radiology and Endorsed by the

- Cardiovascular Interventional Radiological Society of Europe and Canadian Interventional Radiology Association. *J Vasc Interv Radiol* 2010;21(11):1611–30.
- [43] Société française d'anesthésie-réanimation. Révision 2010 de la Conférence de consensus 1992 «Antibioprophylaxie péri-opératoire» <http://www.sfar.org/article/669/antibioprophylaxie-en-chirurgie-et-medecineinterventionnelle-patients-adultes-cc-2010>
- [44] Référentiel de pratiques professionnelles Antibioprophylaxie péri-opératoire, HAS, CFAR, SFAR, juin 2005 http://www.hassante.fr/portail/upload/docs/application/pdf/2009-08/antibio_perioperatoire_rap.pdf.
- [45] Arrêté du 07/01/93, relatif aux caractéristiques du secteur opératoire, mentionné à l'article D. 712-31 du Code de la santé publique pour les structures pratiquant l'anesthésie ou la chirurgie ambulatoire, visées à l'article R. 712-2-1 (b) de ce même code. Ministère de la Santé.
- [46] Norme NF S 90-351 Salles propres et environnements maîtrisés apparentés, AFNOR 2003. (being revised).
- [47] Joffre F, Benne M, Ramon H, Poulhes J. Conception et aménagement d'un secteur de radiologie vasculaire et interventionnelle. *Tech Hosp* 1996;611:34–8.
- [48] Décret n° 94-1050 du 05/12/1994, relatif aux conditions techniques de fonctionnement des établissements de santé, en ce qui concerne la pratique de l'Anesthésie et modifiant le code de la santé publique. Ministère de la Santé.
- [49] Ministère de la Santé et des Sports – DGS. Déchets d'activité de soins à risques, comment les éliminer Guide technique. 2009, 90 pg. http://www.ars.sante.fr/fileadmin/LANGUEDOCROUSSILLON/ARS/2.Votre_sante/Votre_environnement/dechets/guid10.pdf
- [50] SF2H : La qualité de l'air au bloc opératoire, recommandations d'experts, octobre 2004 http://www.sf2h.net/publications-SF2H/SF2H_recommandations-gr-air-2004.pdf.
- [51] Williams DM, Marx V, Korobkin M. AIDS risk and risk reduction in the radiology department. *AJR* 1991;157: 919–21.